Rotating figures in coordinate space

In this lesson we'll look at how the rotation of a figure in a coordinate plane determines where it's located.

A **rotation** is a type of transformation that moves a figure around a central rotation point, called the **point of rotation**. The point of rotation can be inside or outside of the figure.

The pre-image and image

A transformation of a shape always starts with the **pre-image**. The pre-image is usually labeled with capital letters. After the pre-image is rotated, the final version of the figure is called the **image**, which is usually labeled with the same capital letters, plus the prime symbol, $'$. So if figure $ABCD$ is rotated, its image becomes figure $A'B'C'D'$.

The image and pre-image are always congruent to each other, because the rotation never changes the angles measures or side lengths of the figure.

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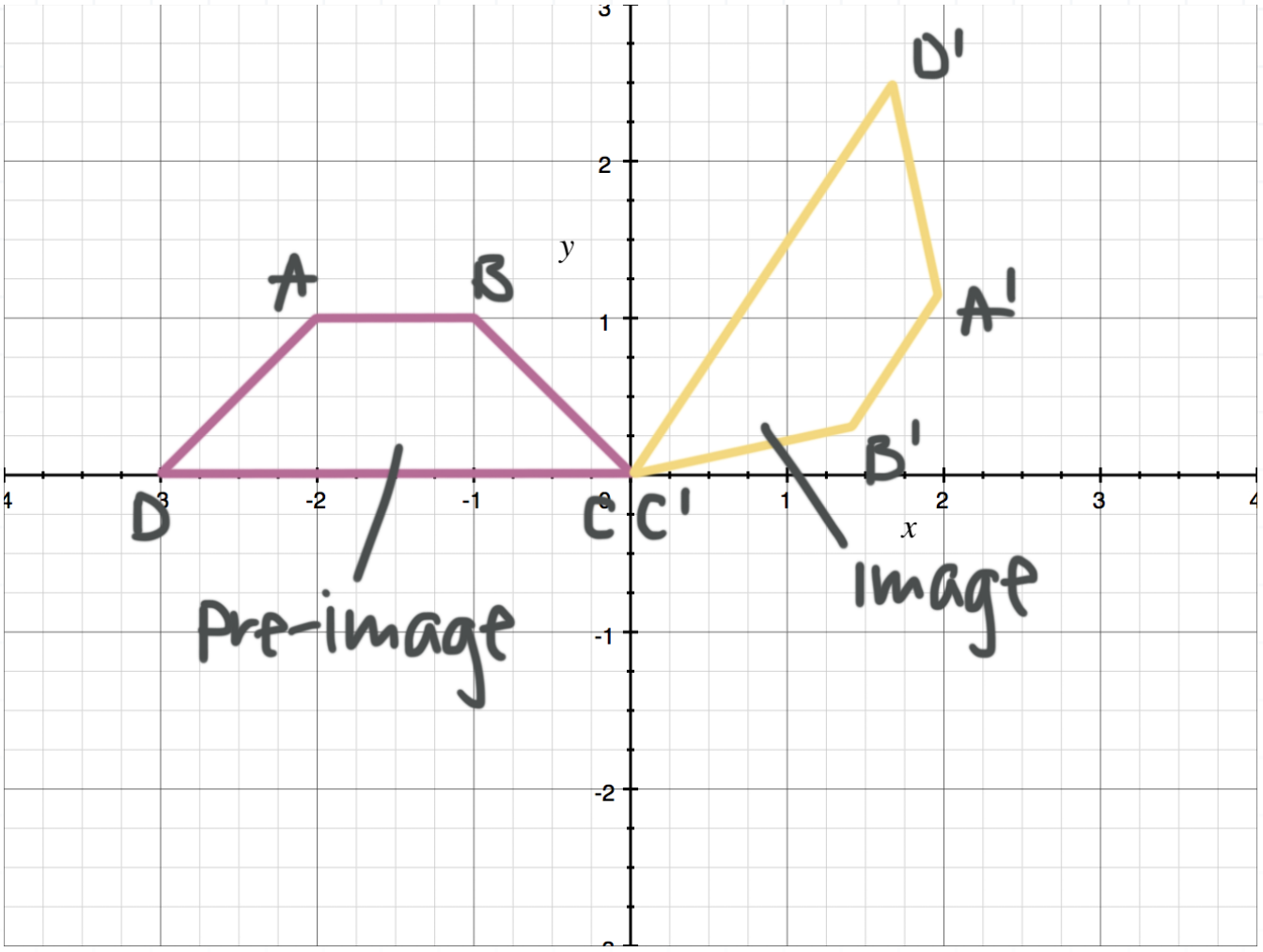

Rotating figures

To rotate an object you need three things:

1. a direction (clockwise or counter-clockwise),
2. an angle (how many degrees you're rotating), and
3. the point of rotation

There are some common rotations about the origin $(0,0)$ that we can use rules for:

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Angle	Direction	Rule
90 degrees	Clockwise	(x,y) --> (y,-x)
90 degrees	Counter-clockwise	(x,y) --> (-y,x)
180 degrees	Clockwise	(x,y) --> (-x,-y)
180 degrees	Counter-clockwise	(x,y) --> (-x,-y)
270 degrees	Clockwise	(x,y) --> (-y,x)
270 degrees	Counter-clockwise	(x,y) --> (y,-x)

If the problem does not give you a direction, then a positive degree measure means a counter-clockwise rotation and a negative degree measure means a clockwise rotation.

Let's look at some examples.

Example

Write a rule to describe the rotation shown in the graph.

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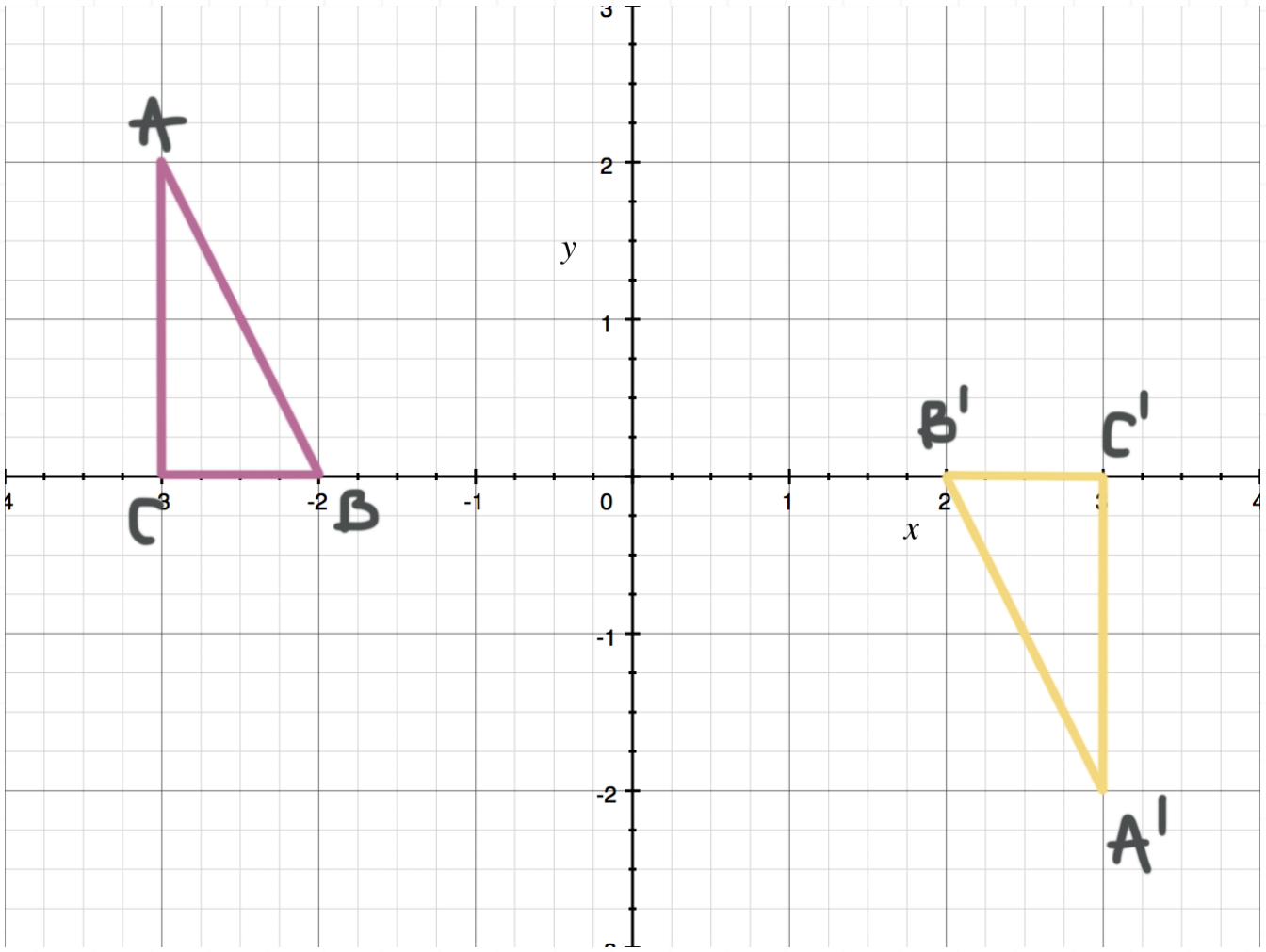

You can visually see that the triangle has been rotated $180°$ about the origin, but you could also look at the rules to see if this follows any of them. Let's compare the points on the pre-image to the points on the image.

The points on the pre-image are

$$A = (-3,2)$$

$$B = (-2,0)$$

$$C = (-3,0)$$

The points on the image are

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$$A' = (3, -2)$$

$$B' = (2,0)$$

$$C' = (3,0)$$

Now we compare the points

$$A = (-3,2) \quad \rightarrow \quad A' = (3, -2)$$

$$B = (-2,0) \quad \rightarrow \quad B' = (2,0)$$

$$C = (-3,0) \quad \rightarrow \quad C' = (3,0)$$

When you compare the points you can see they are following the function rule for a $180°$ rotation clockwise around the origin.

Angle	Direction	Rule
180 degrees	Clockwise	(x,y) --> (-x,-y)

So the relationship between the pre-image and the image is

$$(x, y) \rightarrow (-x, -y)$$

Let's try another example.

Example

Where will point A' be located after point A is rotated $270°$ clockwise around the origin.

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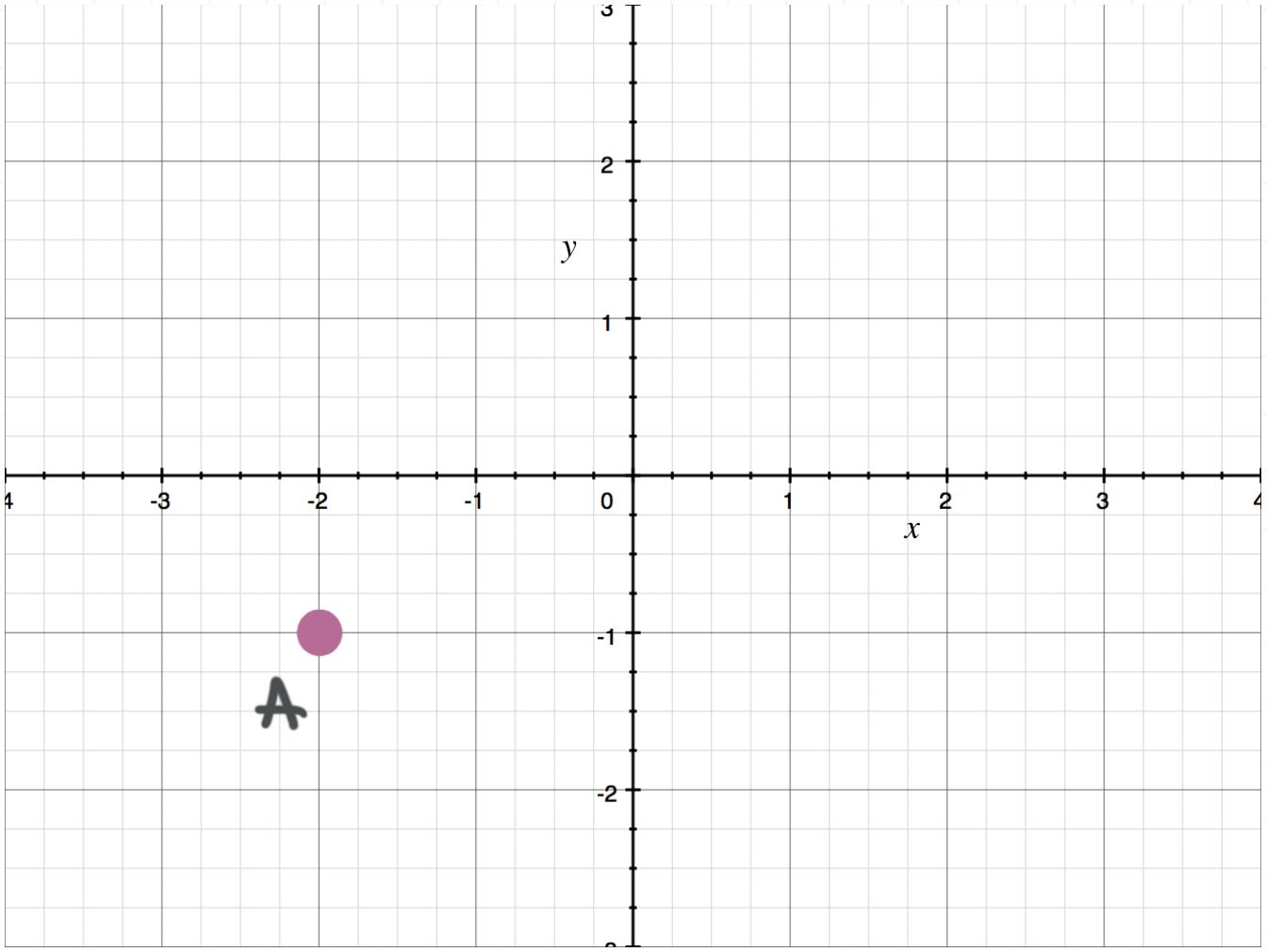

Look up the rule for the rotation of $270°$ clockwise around the origin.

Angle	Direction	Rule
270 degrees	Clockwise	(x,y) --> (-y,x)

Point A is located at $(-2, -1)$, and we use the rule $(x, y) \to (-y, x)$. From our original point $x = -2$ and $y = -1$. So $(-2, -1) \to (1, -2)$. The figure shows point A being rotated $270°$ clockwise around the origin, ending at $(1, -2)$.

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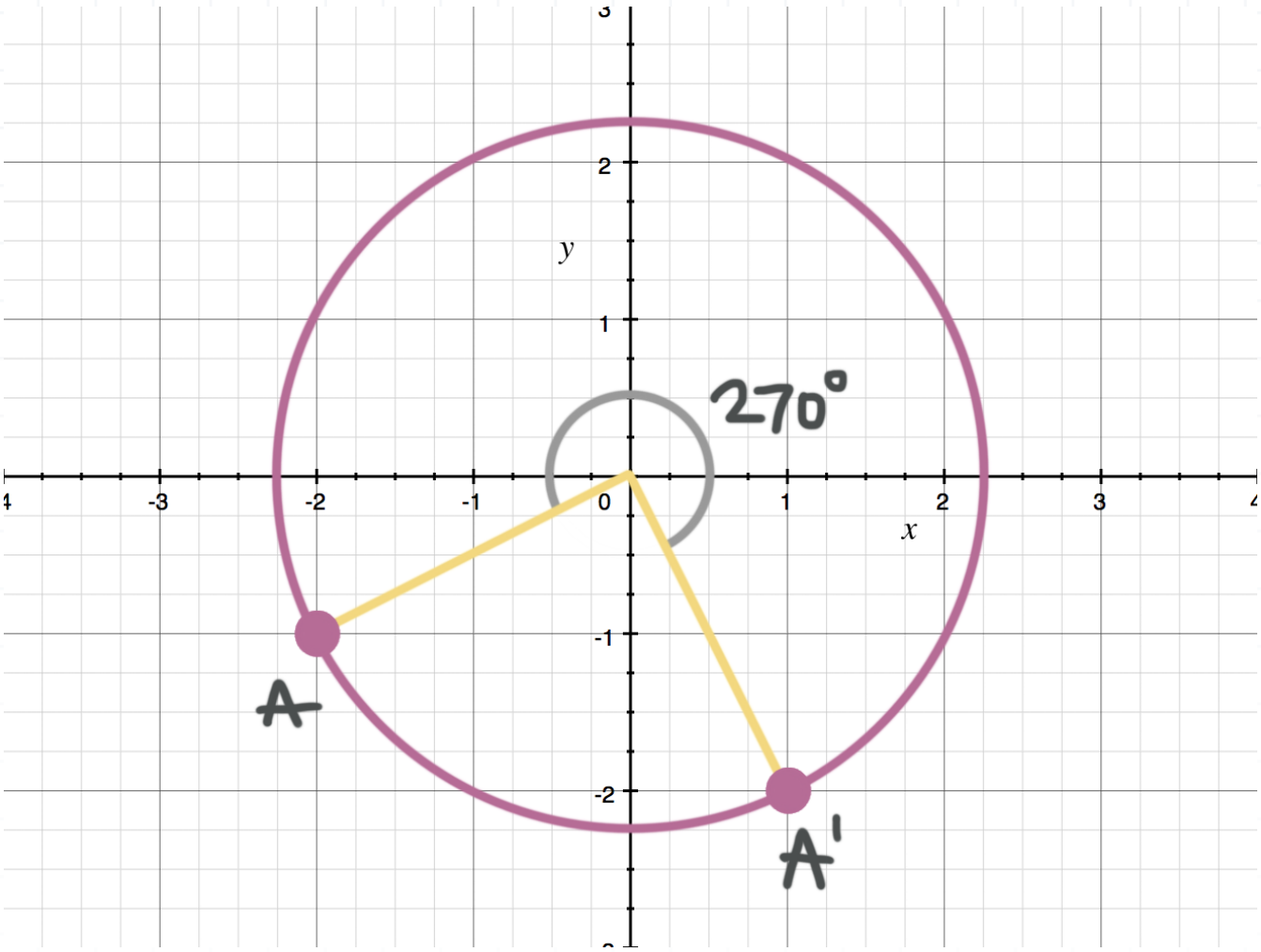

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